AN ASSESSMENT OF PESTICIDE RESEARCH PROJECTS FUNDED BY THE MINISTRY OF THE ENVIRONMENT THROUGH THE ONTARIO PESTICIDES ADVISORY COMMITTEE

1974 – 1975

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Ministry of the Environment

Ontario

The Honourable
William G. Newman,
Minister

Everett Biggs,
Deputy Minister

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The Honourable	Everett Biggs
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RESEARCH PROJECTS FUNDED THROUGH THE ONTARIO PESTICIDES ADVISORY COMMITTEE.

1974-75

I SUMMARY

1) In 1974-75 the Ontario Pesticides Advisory Committee continued a research program established the previous year with three major objectives:

   a) To find alternative pesticides for those deemed environmentally hazardous and thus restricted in use.

   b) To determine potential environmental hazards with pesticides presently in use.

   c) To reduce total pesticide input into the environment.

2) Forty-three applications for research grants totalling $474,218 were received.

3) Four grants totalling $17,475 were awarded for studies on control of diseases and pests of agricultural crops and on biting fly control.

4) Eight grants totalling $41,673 were allocated to studies on potential environmental hazards to non-target organisms associated with pesticide use. Results indicated that under certain conditions some pesticides may influence survival and behaviour of non-target soil organisms, plants, and aquatic organisms.

5) Six grants totalling $39,212 were awarded for programs aimed at reducing pesticide input into the environment. Good progress was made toward development of effective pest monitoring techniques and development of alternative methods of pest control.

6) The total value of the 18 research grants was $98,360, the average value/grant was $5,464 with a range of $1,600-$24,612.

7) The Advisory Committee is satisfied that in general the research done was of high calibre and that productivity was very good.

8) The Advisory Committee is hopeful that every effort will be made to insure that results of promising research programs are implemented as quickly and efficiently as possible.

II RECOMMENDATIONS

The Pesticides Advisory Committee recommends that:

1) The Ministry of Environment continue the program of grants to encourage pesticide research.

2) Funds in the amount of $250,000 be made available for the program in 1976-77.

3) The program continue to be supervised by the Advisory Committee following guidelines developed over the past two years.

4) The Ministry of the Environment encourage appropriate authorities to develop policies and guidelines which will ensure rapid implementation of promising approaches to pest control which present a minimum of environmental hazard.

III REVIEW OF THE RESEARCH PROGRAM

In 1973 the Ontario Pesticides Advisory Committee was allocated $100,000 to sponsor research that would lead to reduction in the overall use of pesticides and to find alternates for those pesticides deemed to be an environmental hazard. Results obtained in the first year of the program were promising and the committee recommended that the research program be continued; that funds be increased to $150,000 per annum by 1975-76; and that the Pesticides Advisory Committee continue its supervision of the Ministry's pesticide research (OPAC, 1974b). The committee is pleased that these recommendations were accepted.

In 1974-75 the Committee was again allocated $100,000 to sponsor research on pesticides. The terms of reference for funding research were based on three objectives, i.e. the need to find suitable replacements for pesticides whose use has been restricted in Ontario; the need to determine if pesticides presently in use pose any serious environmental hazards, and the need to develop more effective approaches to pest control while reducing total pesticide input into the environment. The "Call for Grant Requests" (Appendix I) based on these objectives therefore emphasized studies involving: 1) research leading to registration of environmentally acceptable pesticides especially for use on minor crops (objective 1); 2) studies on the persistence and fate of pesticides in the environment and their effects on non-target organisms (Objective 2); and 3) studies on economic thresholds of pests, on improved application techniques, and on alternative non-chemical approaches to pest control (Objective 3). Invitations for grant applications were sent out in January 1974 to universities, industry and government (Appendix II) with the deadline for applications being February 28, 1974. Decisions on grants to be awarded were made by April 1, 1974.

Forty-three grant applications were received requesting a total of $474,218 (Appendix III). Applications were primarily from university personnel (33) but five were received from the agricultural chemical industry or consulting firms and five from other sources. University applications came from Carleton (1), Guelph (13), McMaster (1), Ottawa (1), Queen's (2), Toronto (6), Waterloo (3), Western (3), and York (3).

Applications were considered by the research subcommittee comprising Mr. R. Boelens, Dr. D.A. Chant, Dr. R. Frank, Mr. K.G. Laver, Dr. F.L. McEwen, Dr. G.R. Stephenson and Dr. C.R. Harris (Chairman) and then by the full Pesticides Advisory Committee. The Committee awarded 17 grants totalling $94,360 holding the remaining funds for use should problems meriting research support develop later in the year. One grant of $4,000 was subsequently allocated, i.e. a total allocation of $98,360 for 1974-75. The average value of the 18 research grants was $5,464 with a range of $1,600 - $24,612. Fifteen of the eighteen grants were made to universities, one to industry, and three to other applicants. University grants went to Guelph (8), York (2), Toronto (1), Waterloo (3) and Western (1).

Direction and progress of the research program was monitored throughout the year by the Research Subcommittee in several ways. Initially several applicants for grants were asked to modify their proposals to include specific problems, falling within the general areas of interest of the applicants, of special interest to the Advisory Committee. Informal meetings between subcommittee members and some of those holding grants were held during the year. In January, 1975, the Advisory Committee sponsored a two day seminar at which the recipients of grants presented a summary of their progress. This approach was very successful in that the Advisory Committee was able to become familiar with the people involved, with their progress, and to make constructive suggestions. Those holding grants were equally enthusiastic in that they had an opportunity not only to present their own results but also to meet with others involved in pesticide work. One suggestion put forward was that in future years, other scientists involved in pesticide research in Ontario, be invited to attend the seminar. In addition to the steps outlined above for monitoring the progress of the research program, each recipient of a grant was requested to submit a progress report at the end of March, 1975 including an Abstract of the work. These are included in this report (Appendix V) and will be summarized only briefly here in relation to the three objectives outlined above.

Objective 1: To find effective alternative pesticides for those deemed environmentally hazardous and thus restricted in use.

Four grants totalling $17,475 were related to this objective.

In general there were alternative insecticides available for control of most insect pests in Ontario when use of the organochlorine insecticides was restricted in 1969-70. However, control measures were lacking for some soil insect pests, particularly cutworms. A joint program begun in 1973, involving the Ontario Fruit and Vegetable Grower's Association (funded by the Advisory Committee), the Ontario Ministry of Agriculture and Food, Agriculture Canada and the University of Guelph resulted in development of effective alternative control measures for cutworms attacking vegetable crops grown on mineral soils (Harris *et al*, 1974) and resulted in temporary registration of one insecticide in 1974 and full registration in 1975. Two other insecticides also show promise.

A review of soil insect problems in Ontario from 1900-1973 (OPAC, 1974a) indicated that, although there are a number of important soil insect pests in Ontario which present a continual control problem, only populations of cutworms and flea beetles appear to have increased in recent years, i.e. since use of the organochlorine insecticides was restricted. In 1974-75 a grant from the Advisory Committee stimulated a study on the biology and control of the crucifer flea beetle in Ontario. In the first year of the project, progress was made in clarifying the life history of the flea beetle, on development of a laboratory rearing procedure, laboratory and field tests were done to assess insecticide efficacy and the significance of declining DDT and dieldrin residues in soil and the increasing incidence of flea beetle damage to crucifers was assessed. The relationship between declining levels of organochlorine

insecticide residues in soil with increasing beetle populations is being assessed (13)*.

Tomatoes are an important field crop in Ontario and receive repeated applications of pesticides, particularly fungicides, throughout the growing season in order to obtain satisfactory pest control. A small grant was allocated to determine if residues of Maneb or Mancozeb were present on tomato foliage, fresh and processed fruit. Analyses will be completed in 1975 (10).

Prior to restrictions on their use, the organochlorine insecticides were used widely in Ontario for biting fly control. Effective alternative approaches to biting fly control have not been developed and, in fact, there is considerable controversy as to whether: a) biting fly problems are sufficiently serious to warrant large scale abatement programs, particularly in southern Ontario; b) the actual species involved; and c) the effectiveness of suggested alternative approaches to control. A study, initiated by the Advisory Committee in 1973 at the Universities of Waterloo and Guelph with the objectives of obtaining: a) a comprehensive review of the biting fly problem in Ontario; and b) specific recommendations as to how the problem should be approached, was continued in 1974. Completion of the study is expected in 1975 (16). A second grant relating to biting fly control was awarded to the University of Guelph in 1974 to study the effectiveness of ULV equipment in applying ground aerosols for mosquito control. The results indicated that neither of the ULV machines tested would be suitable for control of mosquitoes in heavily vegetated areas or in large-scale abatement programs (18).

Objective 2: To determine potential environmental hazards with pesticides presently in use.

Eight grants totalling $41,673 were allocated to this objective. Some work was continued or initiated on the persistence and degradation of pesticides in soil. As a result of concern that surplus pesticides deposited in waste disposal sites in Ontario might migrate into underground water sources, a project was initiated to monitor pesticide migration from selected waste disposal sites. Completion of the first two phases of the study is expected in 1975 (5). In another study an improved analytical method was devised for the herbicide paraquat. It was also shown that paraquat mobility in soil was influenced by salt content (11).

Studies were continued or initiated on the effects of pesticides on non-target organisms.

In soil laboratory studies indicated that low levels of paraquat inhibited *Rhizobium* spp under certain conditions (11).

Recent research has indicated that combinations of pesticides or their degradation products may have effects on non-target organisms which would not occur when the pesticides were used singly. A study on effects of combinations of pesticides with the herbicide, metribuzin, indicated, under both laboratory and field conditions, that it interacted

*Numbers in brackets refer to Abstracts of projects in Appendix V

with several insecticides and some herbicides and fungicides to give synergistic increases in phytotoxicity to plants. Tomatoes were used as the indicator organism. Synergistic action could be reduced or avoided by applying the pesticides separately rather than in combination with appropriate time intervals between applications (17).

Considerable emphasis was placed on potential effects of pesticide residues on non-target aquatic organisms. Four inter-related studies were continued or initiated. The persistence of the insecticide, chlorpyrifos, was studied in an artificial stream (3) and the effects of chlorpyrifos and Abate[R] on the effects of insecticides on important chemical characteristics of water were assessed in artificial ponds (2). Insecticide effects on bacteria in artificial ponds and on phytoplankton in an artificial stream were measured (2,3). In a laboratory study the effects of several herbicides, some of their degradation products, and the insecticide diazinon, on nitrogen-fixing blue-green algae was assessed (4). A study was also initiated on the effects of diazinon on the survival and behaviour of stream invertebrates (9) and on the accumulation of chlorpyrifos in the muscle tissue of fish within a few days of exposure (3). Results of these studies, although preliminary in nature, indicate that some pesticides may influence the behaviour or survival of some aquatic organisms.

A project initiated by the Advisory Committee in 1973 on the potential hazards of granular pesticide formulations to birds was continued. A method of labelling granules was developed and used in experiments with four species of sparrows and mallard ducks. The results indicated that sparrows will eat granules when distributed on natural substrates, but there was considerable variation among species and individuals with respect to amounts consumed (6).

Objective 3: To reduce total pesticide input into the environment.

In the long term, reduction of pesticide input into the environment while at the same time achieving as or more effective pest control should be one of the prime goals of this research program. Pesticide input could be reduced through research in several areas, e.g. determination of economic levels of crop damage; development of more effective soil and crop management techniques; more efficient methods of application; effective pest monitoring techniques; and alternative non-chemical approaches to pest control. Six grants totalling $39,212 were allocated within this general objective.

It is a well-known fact that application techniques are crude i.e. only a small fraction of the pesticide applied may reach the actual target. Two programs were supported in 1974-75 relating to the development of more effective methods of pesticide application. Research on a novel approach to pesticide application involving electrostatic application, first supported in 1973, was continued (8). Results, in the laboratory under "controlled conditions" and in the field using an experimental piece of application equipment have indicated that electrostatically charged particles show some potential for reducing spray drift while at the same time providing more uniform and effective

coverage of the target site. At an immediately practical level, a project to evaluate the efficiency of spray application techniques on row crops was supported. Results of this study indicated that much can be done to improve the efficiency of control obtained with application equipment presently available through the use of proper nozzles, nozzle arrangements, pressure, travel speed, surfactants, etc. (15).

In a few instances, biological control of pests may be feasible. A project on the feasibility of controlling St. John's-wort, a perennial weed in pastures, with two species of Chrysolina beetles was initiated in 1974 with support from the Advisory Committee. The distribution and ecological history of St. John's-wort in Ontario was studied and populations of beetles released at five sites to monitor their effectiveness as control agents (1). In a second project, i.e. biological control of the onion maggot using the sterile male technique involving the University of Guelph, Agriculture Canada and the Advisory Committee, promising results were obtained. In the Keswick Marsh, significant reduction in egg hatch was obtained during the second generation following release of several million sterilized onion maggot adults. Effective control of the second generation was obtained with the sterile male technique eliminating the need for adulticide sprays (12).

Two research projects on development of effective pest monitoring techniques were supported. A study on reduction of fungicide usage on vegetable crops by scheduling sprays according to weather data continued to show promise. Field experiments in both 1973 and 1974 indicated that fungicide use could be reduced by about 50% while still maintaining a high level of carrot leaf blight control (7). Development of a pest monitoring program in the Georgian Bay apple orchards also advanced well. Results indicated that commercially acceptable crops can be produced in intensely monitored apple orchards with a significant reduction in pesticide use. (14). In both these projects it is the opinion of the Advisory Committee that the research has reached the point where the programs can soon be operational.

ASSESSMENT

In assessing progress made in the two years that this program has been in operation the Advisory Committee is well-satisfied. The value of the research being done far exceeds the $100,000/year investment. It is our feeling that this remarkable productivity has been due to several factors: 1) That the program has been kept small enough that the Advisory Committee has been able to: become acquainted with researchers genuinely interested in pesticide research; negotiate directly with them; advise them on appropriate modifications through the expertise on the Advisory Committee; and monitor the work throughout the year; 2) That by strategically placing small grants, initiation of research projects worth hundreds of thousands of dollars by provincial and federal agencies, universities and industry has been stimulated; 3) That cooperation between the various agencies etc. involved has been encouraged by negotiating joint grants; and 4) That the Ministry of the Environment has given the Advisory Committee a great advantage by allowing flexibility in the manner in which it is allowed to operate and supervise its research grant program. Because of this we feel that it has been possible to obtain high productivity.

Part of the success of the research program is that it has been kept small and it is the feeling of the Advisory Committee that the program should not be expanded greatly in the future. A budget increase from $100,000 to $150,000 was requested for 1975-76 primarily because inflationary costs for scientific research have been so great. The Ministry met this request. It is our feeling that again taking the costs of inflation into consideration, a budget of $250,000 for 1976-77 would be adequate.

One important aspect of the research program merits further discussion. The Advisory Committee is particularly concerned that research results be applied as soon as possible. Some of the programs being sponsored by the Committee, particularly those relating to our objective of reducing pesticide input into the environment while still achieving effective pest control, will soon be at the "operational" stage, e.g. the pest monitoring programs aimed at reducing fungicide usage on carrots and insecticide sprays on apples; and, assuming it proves feasible, the sterile male approach to onion maggot control in the Holland Marsh. Implementation of these programs will require adjustments in philosophy, planning and staffing by various government agencies, both provincial and federal, by industry, by universities and by the growers. Present extension programs will require revision and modification. Additional highly qualified staff will be required. The onion maggot program will require mass production facilities. Should responsibility for implementation of these programs be assumed by various ministries of the provincial government, by universities, or by private enterprise? The Advisory Committee suggests that the Ministry of the Environment encourage appropriate authorities in provincial and federal agencies, universities and industry to develop policies and guidelines which will insure rapid implementation of promising approaches to pest control which present a minimum of environmental hazard.

IV REFERENCES CITED

Harris, C.R., Svec, H.J., Sans, W.W., Hikichi, A., Phatak, S.C., Frank, R., and Braun, H.E. 1974. Efficacy, phytotoxicity, and persistence of insecticides used as pre- and postplanting treatments for control of cutworms attacking vegetables in Ontario. Proc. Entomol. Soc. Ont. In Press (1975).

Ontario Pesticides Advisory Committee. 1974a. Review of soil insects in Ontario, 1900-1973. 28 p.

Ontario Pesticides Advisory Committee. 1974b. An assessment of research projects funded by the Ministry of the Environment through the Ontario Pesticides Advisory Committee, 1973-74. 33 p.

APPENDIX I. Format of advertisement inviting applications for research grants from the Ontario Pesticide Advisory Committee, 1974-75

CALL FOR GRANT REQUESTS

The Ontario Ministry of the Environment has a limited amount of funds available to sponsor research that will reduce the overall use of pesticides and find alternates where possible for those that are environmentally hazardous. Funds will be made available on the basis of a negotiated contract for specific research projects. Preference will be given to proposals that will yield results in a relatively short time (less than three years), and funds will be committed on a one-year basis. Research should be in the context of normal use patterns.

The Ministry invites proposals in the following areas:-

1. The economics of pest control including economic threshold levels of pests.

2. Soil management in relation to pest biology.

3. Research leading to the registration of environmentally acceptable pesticides, especially for use on minor crops, including vegetables, greenhouse crops, and ornamentals.

4. Reduction of pesticide usage through improved application techniques.

5. Research on specific non-chemical approaches to pest control.

6. Effects of pesticides on non-target organisms.

7. Interactions occuring between pesticides and their effects on non-target organisms.

8. Studies on the persistence, fate and biological significance of pesticides in the environment with particular reference to parathion, carbofuran, chlordane and its metabolites, and benomyl.

APPLICATION PROCEDURE

Research proposals should be submitted to:-

The Chairman,
Pesticides Advisory Committee,
Ontario Ministry of the Environment,
Fifth Floor, Mowat Block,
Queen's Park,
Toronto, Ontario,
M7A 1A2.

Applications should include the following:-

1. Title of project.
2. Name, address and affiliation of applicant.
3. Discussion of problem.
4. Clear statement of objectives.
5. Plan for the program.
6. Facilities available to the researcher for the conduct of the program.
7. Budget - categorize costs as:

   Personnel - full time and part time;

   equipment, supplies; other.
8. Curriculum vitae on principal investigator.

Applications should be received by February 28, 1974.

APPENDIX II. "Call for Research Grants": Mailing List, 1974-75

ALEX, Prof. J.F., Dept. of Environmental Biology, University of Guelph, Guelph, Ont.

ARMSTRONG, Mr. M.L., Ontario Fruit & Vegetable Growers Association, 301 Ontario Food Terminal, 185 The Queensway, Toronto, Ontario.

BAARCHERS, Dr. W.H., Lakehead University, Thunder Bay, Ontario.

BANDEEN, Dr. J.D., Crop Science Dept., University of Guelph, Guelph, Ontario.

BARLOW, Dr. C.A., Carleton University, Ottawa, Ontario.

BROWNE, Mr. C.R., Senior Project Development Officer, Ontario Research Foundation, Sheridan Park, Mississauga, Ontario.

BROWN, Dr. J.M., School of Hygiene, University of Toronto, Toronto, Ontario.

BUNTING, Dr. John W., Dept. of Chemistry, University of Toronto, Toronto, Ontario.

CHADWICK, Dr. June M., Dept. Microbiology, Queen's University, Kingston, Ontario.

CHEFURKA, Dr. P.M., University of Western Ontario, London, Ontario.

CORBET, Dr. P.S., University of Waterloo, Waterloo, Ontario.

CORKE, Dr. Charles T., Dept. of Microbiology, College of Biological Science, University of Guelph, Guelph, Ontario.

DE LA IGLESIA, Dr. Felix A., Warner Lambert Research Institute, Sheridan Park, Mississauga, Ontario.

DOWNE, Mr. A.E.R., Queen's University, Kingston, Ontario.

FENTON, Dr. M.B., Carleton University, Ottawa, Ontario.

FLETCHER, Dr. R.A., Dept. of Environmental Biology, University of Guelph, Guelph, Ontario.

FOWLE, Dr. C.D., Dept. of Biology, York University, 4700 Keele St., Downsview, Ont.

FROSST, Mr. Alan C., McMaster University, Hamilton, Ontario.

FROST, Dr. Roger A., University of Toronto, Toronto, Ontario.

GEORGE, Prof. John A., Faculty of Science, Dept. of Zoology, University of Western Ontario, London, Ontario.

GIBO, Dr. D., Erindale College, University of Toronto, Toronto, Ontario.

GILLESPIE, Dr. T.J., Dept. of Land Resources Science, University of Guelph, Guelph, Ontario

HARMSEN, Dr. R., Biology Dept., Queen's University, Kingston, Ontario.

HOLSWORTH, Dr. Wm. N., University of Western Ontario, London, Ontario.

HUTCHINSON, Dr. T.C., University of Toronto, Toronto, Ontario.

INCULET, Dr. I.I., Faculty of Engineering Science, The University of Western Ontario, London, Ontario.

KAYE, Dr. B.H., Director of Fine Particles Research Institute, Laurentian University, Sudbury, Ontario.

KETCHESON, Prof. J.W., University of Guelph, Guelph, Ontario.

KNERER, Dr. Gerd, University of Toronto, Toronto, Ontario

MAHANEY, Dr. W.C., York University, 4700 Keele St., Downsview, Ontario.

MAYFIELD, Dr. C.I., Faculty of Science, Dept. of Biology, University of Waterloo, Waterloo, Ontario.

McEWEN, Dr. F.L., Chairman, Dept. of Environmental Biology, University of Guelph, Guelph, Ontario.

McKAY, Dr. D., Chemical Engineering Dept., University of Toronto, 200 College St., Toronto, Ontario.

NORDIN, Mr. V.J., University of Toronto, Toronto, Ontario.

ORLOB, Dr. G.B., Department of Botany, University of Toronto, Toronto, Ontario.

PATRICK, Mr. Z.A., University of Toronto, Toronto, Ontario.

PHILLIPS, Dr. C.R., Dept. of Chemical Engineering & Applied Chemistry, University of Toronto, Toronto, Ontario.

STEPHENSON, Dr. G.R., Dept. of Environmental Biology, University of Guelph, Guelph, Ontario.

TOMECKO, Mr. J.W., University of Waterloo, Waterloo, Ontario.

WEINBERGER, Dr. Pearl, Dept. of Biology, The University of Ottawa, Ottawa, Ontario.

WEST, Dr. A.S., Queen's University, Kingston, Ontario.

WILSON, Mr. M.A., Head, Chemistry Department, Eco-Research Ltd., 265 Hymus Blvd., Pointe Claire, Quebec.

WRIGHT, Dr. Russell, Dept. of Environmental Biology, University of Guelph, Guelph, Ontario.

APPENDIX III. Research proposals submitted to the Ontario Pesticide Advisory Committee, 1974-75

No.	Applicant(s)	Location	Project Title	Amount requested
1	Alex, J.F.	University of Guelph	Biological control of St. John's-wort.	$ 7,370.
2	Boyer, M.G. Fowle, C.D.	York University	The response of bacteria, algae and invertebrates in small ponds to applications of mosquito larvicides.	10,952.
3	Brown, J.R.	University of Toronto	The effect of Dursban when applied in the form of a larvicide preparation upon the micro-flora uptake in bottom sediments.	5,573.
4	Bunting, J.W.	University of Toronto	The chemistry of carbofuran, benomyl and related carbamate pesticides.	12,400.
5	Busch, L.V.	University of Guelph	Effect of cropping sequence and other agronomic practices on the survival of pathogenic Verticillium species in the soil.	8,500.
6	Chadwick, J.M. Faulkner, P.	Queen's University	The utilization of insect Polyhedrosis viruses as an alternative to chemical pesticides: Studies on the viral factors which contribute to the host range of susceptible insects and an investigation of acquired immunity of insects to viruses.	15,000.
7	Corke, C.	University of Guelph	Interactions of pesticides and their metabolites with microbial transformations in soil and fresh water ecosystems.	4,200.
8	Ellis, C.R.	University of Guelph	Populations of insect pests and beneficial insects and mites in the soil of field corn grown with conventional or zero tillage.	5,780.
9	Farquhar, G.J. Rovers, R.A.	University of Waterloo	Study plan to monitor pesticide migration from waste disposal sites.	4,000.

APPENDIX III. (continued)

No.	Applicant(s)	Location	Project Title	Amount requested
10	Fletcher, R.A.	University of Guelph	Effects of 2,4-D on mammals.	$10,192.
11	Fowle, C.D.	York University	Potential hazard to birds from granular formulations of pesticides.	5,806.
12	George, J.A.	University of Western Ontario	Earthworms as prey for larvae of *Coenosia tigrina*.	No Value
13	Gibo, D.	University of Toronto	A study of techniques for increasing populations of predatory social wasps for biological control of insect pests of crops.	8,500.
14	Gillespie, T.J. Sutton, J.C.	University of Guelph	Reduction of fungicide usage on vegetable crops by scheduling sprays according to weather data.	8,351.
15	Harmsen, R.	Queen's University	The application of systems modelling to crop-pest population forecasting.	15,000.
16	Hofstra, G. Edington, L.V.	University of Guelph	Reducing the use of fungicide on onions.	13,560.
17	Inculet, I.I.	University of Western Ontario	Electrostatic application of pesticides in orchards and field crops.	9,800.
18	Kaushik, N.K.	University of Guelph	Effects of sublethal concentration of diazinon on stream invertebrates.	7,000.
19	Kaye, B.H. Naylor, A.G.	Fine Particles Research Institute	Studies aimed at achieving drastic reduction in active pesticides per acre through electrostatic manipulation of fine particle system.	6,000.

No.	Applicant(s)	Location	Project Title	Amount requested
20	Krushelniski, J.J.	H.J. Heinz & Co.	Evaluation of E.T.U. residues on both tomato foliage, and fresh and processed fruit sprayed with various maneb and mancozeb formulations.	$ 4,750.
21	Langford, C.H.	Carleton University	Induced photochemistry as a fate of parathion carbofuran, and chlordane.	2,890.
22	Last, A.J.	Ontario Research Foundation	Control of pesticide drift by close sizing of liquid spray particles using ultrasonic and other specialized techniques.	45,900.
23	MacKay, D.	University of Toronto	A study of the rate of evaporation of the pesticides parathion and diazinon under Ontario climatic conditions.	7,700.
24	MacNeil, B.H.	University of Guelph	The development of benomyl resistance in _Cladosporium fulvum_, a fungal pathogen in green house tomatoes.	9,000.
25	McEwen, F.L.	University of Guelph	Control of the onion maggot, _Hylemya antiqua_ (Meigen), by use of the sterile male technique.	24,612.
26	Mahaney, W.C.	York University	Effect of deep tillage and soil pollutants on grey-brown podzolic soils in southern Ontario.	11,000.
27	Mayfield, C.I.	University of Waterloo	Effect of the dipyridyl herbicides paraquat and diquat on non-target organisms.	8,150.
28	Neil, J.H.	Limnos Ltd.	Control of mosquitoes using the fathead minnow (_Pimiphales promalis_).	3,800.
29	Ontario Fruit & Vegetable Growers' Association	Toronto	Spray application techniques to reduce pesticide load on row crops.	3,400.

No.	Applicant(s)	Location	Project Title	Amount requested
30	Ontario Fruit & Vegetable Growers' Association	Toronto	To test feasibility of implementing the pest monitorizing system for apple areas of Ontario.	$ 3,400
31	Ontario Fruit & Vegetable Growers' Association	Toronto	To register spray compounds for control of dark-sided cutworm, Euxoa messoria (Harr.) on minor crops grown on mineral soil.	2,700.
32	Ontario Fruit & Vegetable Growers' Association	Toronto	Biology and control of flea beetles attacking minor vegetable crops grown in Ontario.	3,800.
33	Orlob, G.B.	University of Toronto	Alternative methods of chemical control in the home garden.	7,600.
34	Phillips, C.R.	University of Toronto	Atmospheric degradation of pesticides.	7,610.
35	Safe, S.	University of Guelph	Photochemistry of pesticides and related compounds.	4,200.
36	Sawyer, T.	R.R. #1, Freelton	Weed and chemical farm survey in corn and beans in south western Ontario.	10,000.
37	Smith, S., Downer, R.G., Corbet, P. and Wright, R.	University of Waterloo University of Guelph	Mosquito control in Ontario.	8,175.
38	Spenser, I.D.	McMaster University	Application of radioactive tracer methods to a study of the metabolic fate of pesticides in plant and animal tissues.	19,700.
39	Stephenson, G.R. Phatak, S.C.	University of Guelph	Phytotoxic interactions involving herbicides, herbicides mixtures and other pesticides in crop plants.	14,373.

No.	Applicant(s)	Location	Project Title	Amount requested
40	Weinberger, P.	University of Ottawa	Tree and grass seeds as carriers of pesticides and their consequences upon forest fauna and wildlife.	3,500.
40	Wilson, M.A.	Eco Research Ltd.	Effect of some carbamates on the aquatic environment.	$65,764.
41	Wright, R.E.	University of Guelph	Ultra low volume ground aerosols of insecticides for control of mosquitoes in southern Ontario.	$11,210.
42	Zajic, J.E.	University of Western Ontario	Effect of pesticides upon symbiotic and non-symbiotic nitrogen fixation.	33,000.

Total research funds requested in 1974-75	$474,218.
Total research funds allocated to the Ontario Pesticide Advisory Committee in 1974-75	100,000.

APPENDIX IV. Research grants allocated by the Ontario Pesticides Advisory Committee, 1974-75

No.	Applicant(s)	Location	Project Title	Amount granted
1	Alex, J.F.	University of Guelph	Biological control of St. John's-wort	$ 2,000.
2	Boyer, M.G. and Fowle, C.D.	York University	The response of bacteria, algae and invertebrates in small ponds to applications of mosquito larvicides.	10,000.
3	Brown, J.R.	University of Toronto	The effect of Dursban when applied in the form of a larvicide preparation upon the micro-flora uptake in bottom sediments.	4,373.
4	Corke, C.T.	University of Guelph	Interaction of pesticides and their metabolites with microbial transformations in soil and fresh water ecosystems.	2,700.
5	Farquhar, G.J. and Rover, R.A.	University of Waterloo	Study plan to monitor pesticide migration from waste disposal sites.	4,000.
6	Fowle, C.D.	York University	Potential hazard to birds from granular formulations.	1,600.
7	Gillespie, T.J. and Sutton, J.C.	University of Guelph	Reduction of fungicide usage on vegetable crops by scheduling sprays according to weather data.	5,400.
8	Inculet, I.I.	University of Western Ontario	Electrostatic application of pesticides in orchards and field crops.	4,000.
9	Kaushik, N.K.	University of Guelph	Effects of sublethal concentrations of diazinon on stream invertebrates.	4,000.

No.	Applicant(s)	Location	Project Title	Amount granted
10	Krushelniski, J.	Leamington, Ontario	Evaluation of E.T.U. residues on both tomato foliage, and fresh and processed fruit sprayed with various maneb and mancozeb formulations.	$ 1,000.
11	Mayfield, C.I.	University of Waterloo	Effect of the dipyridyl herbicides paraquat and diquat on non-target organisms.	5,000.
12	McEwen, F.L.	University of Guelph	Control of the onion maggot, <u>Hylemya antiqua</u> (Meigen), by use of the sterile male technique.	24,612.
13	Ontario Fruit and Vegetable Grower's Association	Toronto	Biology and control of flea beetles attacking minor vegetable crops grown in Ontario.	3,800.
14	Ontario Fruit and Vegetable Grower's Association	Toronto	The feasibility of implementing the pest monitoring system for apple growing areas of Ontario.	1,600.
15	Ontario Fruit and Vegetable Grower's Association	Toronto	Spray application techniques to reduce pesticide load on row crops.	1,600.
16	Smith, S., Downer, R.G., Corbet, P. and Wright, R.	University of Waterloo University of Guelph	Mosquito control in Ontario.	8,175.
17	Stephenson, G.R.	University of Guelph	The study of phytotoxic herbicides	10,000.
18	Wright, R.	University of Guelph	Ultra low volume ground aerosols of insecticides for control of mosquitoes in southern Ontario.	4,500.
			Total:	$98,360.

APPENDIX V. Progress reports (Abstracts) on projects funded by the Ontario Pesticides Advisory Committee, 1974-75

1. Alex, J.F.* and J.M. Dougan. Biological Control of St. John's Wort.

St. John's-wort, a perennial weed in pastures, may cause photosensitization in sensitive livestock. Control by conventional herbicides has proven impractical. Two species of Chrysolina beetles (Coleoptera: Chrysomelidae) that have been used effectively against the weed in Australia and California were released on the weed near Picton, Ontario, by Agriculture Canada scientists in 1969.

The present study has examined the distribution and ecological life-history of St. John's-wort in Ontario, monitored the effectiveness of the beetles as a control agent under our conditions, and examined the response of associated pasture vegetation to the biological elimination of St. John's wort.

Field and herbarium surveys revealed that St. John's-wort occurs in every county, region and district of the province. Plants from various locations were transplanted to a research garden at Guelph for comparative studies.

Seedlings from 18 sources across the province displayed variations in number and size of basal shoots, in leaf size and arrangement, and in development of flowers under uniform growth conditions. Increased shade reduced shoot development, and retarded or inhibited flower production.

Seed germination was about 80% at diurnal temperature regimes of 9-15°C and 15-27°C, but was usually inhibited at 27-35°C. Washing seeds in either distilled water or 10% ethanol reduced germination at 9-15° by one-half in all cases. If there is a comparable effect due to fall rains, this would help explain the relative absence of seedlings in the field despite the high seed production of St. John's wort.

In the immediate vicinity of the original release near Picton, the density,frequency, and average plant size had decreased since previous analyses and fell sharply between 1973 and 1974. From 1973 to 1974, there was a corresponding decrease in beetle population in this area, indicating an equilibrium between insect population and the reduction in their host plant. In peripheral areas the insect population has continued to increase but the weed is now beginning to decrease.

Five sites were selected in the Guelph region for new releases, the vegetation analysed, and morphological and growth habit characters examined. Populations of St. John's-wort ranged from "weedy" infestations where it was a dominant, aggressive component of the vegetation, to more stable, "naturalized" infestations where plants were generally smaller, less obvious, and better integrated into the associated pasture or old-field vegetation. Variations were due in part to soil factors; cultural practices and competition from associated plants. Overwintering survival and mortality of autumn basal growth of St. John's-wort were also compared between sites.

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* ______________: Researcher(s) to whom grant was awarded.

In late summer, 1974, one population of beetles from either Ontario, British Columbia, or California, was released at each of the five sites. All produced eggs in the field during the fall of 1974.

At the Picton site, winter mortality of adults was extremely high in 1973-74 due to poor snow cover. This contributed, at least partially, to the decreased population in 1974. Dehydration of the leafy basal shoots upon which eggs were laid contributed more to egg mortality than did exposure to freezing temperatures. In 1974, the majority of the new generation came from eggs laid the previous fall. Both Chrysolina hyperici and C. quadrigemina are persisting in approximately equal proportions at the Picton site.

2. Boyer, M.G., Fowle, C.D., and Butcher J.E. The response of bacteria, algae and invertebrates in small ponds to applications of mosquito larvicides.

This interim statement attempts to summarize some of the information obtained from nearly two years of studies on the effects of Abate^R and Dursban^R in artificial ponds. The nature of these ponds has been described in past reports, but briefly they consisted of excavations lined with polyethylene, filled with water and inoculated with known quantities of organic litter from temporary woodland pools containing large numbers of mosquitoes as well as a diversity of other invertebrates and microorganisms.

In the experimental work we have attempted to explore three relevant aspects of pond dynamics. Since bacteria play such a key role in the decomposition of organic debris we have assessed the impact of the pesticides on their numbers. Secondly we have looked at many of the important chemical characteristics and their response to treatment of pond waters. These chemical characteristics serve as indicators of a complex series of events, without which biological changes would not occur. Thirdly we have examined the effect of the pesticides on the overall productivity of the ponds both through comparisons of carbon dioxide and oxygen production under certain conditions, and through a study of the rate of which organic matter is decomposed.

3. Brown, J.R. The effect of Dursban^R when applied in the form of a larvicide preparation upon the micro-flora uptake in bottom sediments.

The effect of 0,0-diethyl 0-(3,5,6-trichloro-2-pyridyl) phosphorothioate (Dursban^R) on the growth of fresh water phytoplankton under natural conditions has been studied. It was found that for most types of phytoplankton concentrations of Dursban in the range of 2-20 ppb. inhibit growth. The following types of phytoplankton have been studied: Ankistrodesmus falcatus, Ankistrodesmus spiralis, Tetraedron sp., Ceratim sp., Dinobyron sp., Gonatozygan sp., Scenedesmus dimorphus, and Trachelomonas sp. Results showed that Dursban produced a similar effect upon the growth of these, as well as combined Diatoms and Novicula pelliculosa in pure culture. However, it was found that the growth of Ceratium sp. was not inhibited. (The results of the present investigation on the effect of Dursban upon fresh water phytoplankton confirm the findings from the previous year.)

An artificial stream has been constructed, 30 feet in length, with a maximum flow rate of 90 cubic feet per minute and with temperature controls operating between 5-25° C. The rate of flow and temperature can be varied. Experiments have been carried out in the artificial stream to determine the uptake of Dursban by a number of piscine species. It has been found that some species of fish, such as Crayfish, Sunfish, Brown Bullhead, Creek Shiner, Gar Pike, Rainbow Trout and Rock Bass may produce up to a 500-fold concentration of Dursban in the muscle tissue within a few days of exposure. These findings are similar to those given by other workers.

The effect of small concentrations of Dursban on phytoplankton is important since phytoplankton provide the food for higher organisms and thus any pollutants are incorporated into the food chain. It is likely, therefore, that any changes in the phytoplankton will ultimately effect fish; particularly those at the end of the food chain.

4. Corke, C.T. Interations of pesticides and their metabolites with microbial transformations in soil and fresh water ecosystems.

A study is in progress on the interactions of representative herbicides of the classes, s-triazine, substituted ureas, phenylcarbamates and acylanilides with axenic cultures of nitrogen-fixing blue-green algae, *Anabaena inaequalis*, *A. aequalis* and *Gleotrichia echinulta*. The major metabolites of cyanazine, atrazine, diuron and propanil were assessed for their possible phytoxicities as well. A total of 20 compounds were included in this part of the study.

The concentrations of compounds used during this investigation were between 0.1 ppm and 1.0 ppm, and are much lower and realistic than reported in the literature on this subject. Cyanazine, atrazine and diuron inhibited the growth of the two *Anabaena* spp. completely at 0.1 ppm, while growth of *G. echinulta* was completely suppressed by cyanazine (0.1 ppm), atrazine (0.1 ppm) and diuron (0.1 ppm), and 20% reduction of growth was noted with propanil at the same concentration. Growth of *A. inaequalis* was inhibited completely by isopropylphenylcarbamate (0.1 ppm), Velpar (0.25 ppm), Outfox (0.25 ppm) and 50% reduction in growth was obtained with chloroisopropylphenyl carbamate (1.0 ppm).

All of the degradation products of the substituted ureas linuron and diuron including DMU (3-(3,4-dichlorophenyl)-1-methyl urea), DU (3,4-dichlorophenyl urea) and 3,4-DCA (3,4-dichloroaniline) were phytotoxic to the test species. For example, growth of *A. affinis* was completely inhibited by DMU (0.1 ppm), and reduced by about 30% by 3,4-DCA (0.1 ppm) and DU (0.5 ppm). The de-ethylated form of cyanazine (2-chloro-4-(1-cyano, 1-isopropylamino)-6-amino-s-triazine) was found to affect growth of *Anabaena spp*. at 0.5 ppm. The amido derivative of cyanazine (2-chloro-4-(1-amido, 1-isopropylamino)-6-ethylamino-s-triazine was phytotoxic to *A. affinis*, reducing cell yield by about 25% at 0.5 ppm. Other metabolites of the s-triazines showed no significant effects on algal cultures at levels of 1 ppm.

The effects of pesticides on the nitrogenase activity of the algae were determined by gas chromatographic determination of the reduction of acetylene to ethylene. Cells were grown in N-free medium and incubated with 10% atmosphere of acetylene in air. Appropriate control cells and herbicide-treated cells were compared for their ability to form ethylene for experimental periods up to 12 hours. None of the herbicides or metabolites was observed to significantly reduce nitrogenase activity at 0.1, 0.5 and 1.0 ppm.

The insecticide diazinon was found to be extremely toxic to nitrogenase activity completely inhibiting acetylene reduction at an applied level of 0.05 ppm. No inhibition was noted at 0.005 ppm. This insecticide was as toxic to nitrogenase activity as the mercuricion.

5. Farquhar, G.J., and Rovers, R.A. Study plan to monitor pesticide migration from waste disposal sites.

This project commenced in the fall of 1974 and no report of any substance is available at this time.

6. Fowle, C.D. Potential hazard to birds from granular formulations.

This project was initiated at the request of OPAC in June, 1973, and was continued during the summer of 1974. A method of labelling granules with chromic oxide was developed in 1973 and used in 1974 in experiments with four species of sparrows (house, savannah, chipping and song) and in preliminary tests with mallard ducks.

It appears that the sparrows do eat granules when distributed on natural substrates. There is considerable variation among species and individuals with respect to amounts consumed. Each species selects granules in a particular size range.

It is now proposed to make a survey of the types of granular formulations available and their use patterns. This information, together with with information on the avian toxicity of the pesticides involved, will help in deciding whether any birds are really at risk from poisoning by granular formulations.

7. Gillespie, T.J., Sutton, J.C., and Langenberg,W.J. Reduction of fungicide usage on vegetable crops by scheduling sprays according to weather data.

Since 1972, development of carrot leaf blight (*Alternaria dauci*) in relation to weather conditions has been studied in the Holland Marsh, Ontario. The objective was to develop a rational scheme for timing sprays that would control the disease with a minimum amount of fungicide. This objective was achieved by combining fundamental studies in controlled environment with empirical studies in the field.

The controlled environment studies concentrated on conidial production, germination, and on the growth of germ-tubes. *A. dauci* produced conidia on weak carrot agar under cool conditions (11 to 23 C) during a dark period of at least 10 hours. A light period following the dark period was found to hasten maturation of the spores by at least 2 hours. Conidia were also found to be produced in the light between 15 and 19 C. Conidia incubated in liquid water at various temperatures for periods up to 9 hours were found to germinate under a broad temperature range (5 to 30 C). However, germ-tube growth required a much narrower temperature range of between 15 to 30 C. Germ-tube growth was found to be more sensitive to temperature than germination. Germinated single spores incubated on weak carrot agar at various temperatures for periods up to 9 hours were found to have a maximum rate of mycelial growth at 28 C.

In the field, measurements were made of temperature, relative humidity, leaf wetness duration, wind velocity, sunshine, air-borne spore concentration and leaf area blighted. Results of spore trapping indicated that rapidly decreasing relative humidity, increasing wind velocity, and the drying of leaves accompanied the beginning of spore release. On the average, maximum numbers of air-borne conidia were recorded at 1300 hr. EDT. Numerous air-borne *A. dauci* conidia were trapped during the month of August in 1973 and 1974. Cooler conditions in September greatly reduced the number of air-borne conidia.

From the controlled environment and field studies, guidelines for scheduling fungicide applications were derived.

1. Cloudy days (more than 70% sky cover) are required to make the crop susceptible.

2. Rain, dew or irrigation must wet the leaves long enough that infection occurs. The length of the required wet period at various temperatures is defined in this thesis.

By using these guidelines, growers can be warned if it is necessary to spray. More accurate timing of fungicide applications will result in:

1. Substantial savings to the grower in labour and spraying costs along with increased yield due to lower carrot losses.

2. A reduction of fungicide load on the environment.

Field experiments during 1973 and 1974 showed that fungicide usage could be reduced by 50%, while maintaining a high level of carrot leaf blight control.

8. Inculet, I.I., Castel, G.S.P., and Kelly, C.B. Electrostatic application of pesticides in orchards and field crops.

The current project started in June, 1973. During that year the research team tested the effectiveness of the proposed new method in a series of experiments both at the Guelph experimental orchard and in the U.W.O. Applied Electrostatics Laboratories. Experiments with dry powers, charged and sprayed with a commercially available electrostatic gun, used in the painting industry, showed significantly higher deposition on both sides of the leaves when the voltage was "ON". Preliminary experiments with water-based liquid formulations were inconclusive on account of operational problems encountered with the unit built at U.W.O. (There was nothing commercially available for charging and spraying conductive liquids.) However experience gained with the unit proved to be most valuable in the subsequent work.

At the February 7, 1974 project review, the Pesticides Advisory Committee requested that the research team focus its efforts on: a) Control of the particle size of liquid formulations; and b) Development of portable equipment for practical application.

Research results in 1974 may be summarized as follows:

A. Control of the Particle Size of Water-Based Sprays

(1) General

A survey was undertaken of commercially available paint spray equipment and it was found that none of it was satisfactory for this application for the following reasons: a) paint spray equipment is designed to be used in close proximity to the object to be coated (typically 8" - 20"). Hence both particle drift and inadequate charge are problems when space charge deposition is attempted; and b) the majority of the equipment was designed for use with non-conductive paint solvents and hence was unsuitable for use with water-based sprays.

One company (DeVilbiss Co.) was experimenting with a modification to an existing gun design to allow it to be used with water-based paints. Useful information was obtained on their equipment. However, their modifications produced no improvement in the particle charging and, in fact, simply consisted of electrically insulating the paint supply and utilizing their existing gun design.

An attempt was also made to obtain a spinning cone atomizer from Ransburg Corp. (As reported last year, it is felt that this type of unit should provide good sizing and charging of particles.) However,as a result of patent constraints, it proved impossible to purchase or even rent a spinning cone unit from this company.

As a result of this survey, it was concluded that the study should concentrate on investigation of ways in which electrostatic forces could be combined with conventional atomizers to achieve desired results.

(2) Conductive-Induction Charging and Electrostatically Enhanced Atomization

(a) The Principle of Charging and Atomization

It is well known that electrostatic forces can influence the degree of atomization of conductive liquids (this is commonly demonstrated by the so-called "Franklin Fountain"). If a conductive liquid is electrically charged, while a jet emerges from this liquid, surface charges concentrate at the end of the jet producing electrical forces which enhance the atomization. As a liquid droplet is formed, it carries off electrical charge. The size of the resulting droplets is determined by the balance of the electrical charge on the droplet and the surface tension of the liquid. It is of interest to note that this atomization results from hydraulic and electrical forces, i.e. no air is required.

Although this effect is well known and easily demonstrated with fine jets, it was not known what would happen if electrostatic charges were to be superimposed on standard mechanical type nozzles. As a result, a series of experiments were carried out in the laboratory with a selected range of atomizers. The nozzles were chosen from among those which produce sheets or cones of liquid prior to atomization.

(b) Experimental Results

(i) Electrostatic Atomization with a Single Tube:

The apparatus used for tests involved single tubes. Hypodermic needles of various sizes were used for the tubes and water containing a dye as the liquid. All tests were carried out for a 10 second period and measurements were made of: (a) liquid flow; (b) distance to dispersion of jet; (c) total charge on droplets; (d) coating effectiveness of the spray.

Results from the coating experiments were not too satisfactory and are not reported here.

(ii) Electrostatic Atomization with Multiple Tubes Mounted on a Hemispherical Head:

Two series of tests were carried out: one with nine No. 23 gauge hypodermic needles and one with seventeen No. 25 gauge needles. The spray heads were mounted in a plastic enclosed chamber containing a number of test plates. All the needles in the above experiments were prone to clogging and the obtained flow rates were very limited. The results, however, indicated the effectiveness of the electrostatic enhancement of the atomization.

(iii) Experiments with Commercially Available Nozzles:

Tests were carried out with six different nozzle types and mean droplet sizes as a function of voltage pressure, temperature and detergent additives were determined.

B. Work on Development of a Portable Unit for Practical Application

Experimental equipment was built comprising an insulated pressure tank inside a grounded box. The high voltage was applied directly to the pressure tank. A water base formulation served as the sole conductor of electric charge to the droplets formed by the nozzle. The nozzle was mounted in a light plastic frame above the tree to simulate injection from the top. The experiment, carried out on October 22, 1974 at Guelph, demonstrated the successful operation of the new small scale apparatus which uses the liquid itself for the high voltage conduction. There was no clogging of the nozzle and the voltage was maintained throughout the experiment without any breakdown. The low volume pressure tank and corresponding Steinen-A500 nozzle could not simulate the actual behaviour of a large size electrically charged aerosol cloud which is expected to be produced by a larger size unit. However, the investigators are satisfied as to the soundness of the working principle of the new apparatus.

9. Kaushik, N.K. Effects of sublethal concentrations of diazinon on stream invertebrates.

Among stream invertebrates, published results for lethal doses of diazinon are available only for *Gammarus lacustris*, *Pteronarcys californica* and some mulluscs. In order to record effects of sublethal doses of diazinon on various stream invertebrates, it was imperative, therefore, to determine first the TLm values for as many species as possible. So far such determinations have been made for nine species (3 amphipods, 2 ephemeropterans and one each of decapod, isopod, plecopteran and trichopteran). Static bioassay technique was used in all cases. Although the experimental conditions are not strictly comparable, TLm value obtained (0.3 ppm) for *Gammarus lacustris* was slightly less than that reported (0.5 ppm) in literature. Values for other species ranged between 0.025 ppm and 0.45 ppm.

Preliminary studies on the effect of sublethal (10% of TLm value) dose of diazinon on the rate of oxygen uptake by *Gammarus lacustris* limnaeus have also been completed. In most cases oxygen uptake per gm body weight was more in case of gammarids exposed to diazinon. More detailed studies are in progress. To study the effect on drift activity of *Gammarus* and other stream invertebrates a labatory stream made of fiberglass and provided with a light source and photocells (to record animal movement) has been installed. Studies on this aspect have just been initiated. Long range plans also include investigations on the effects of sublethal doses of diazinon on growth, fecundity and reproduction.

10. Krushelniski, J. Evaluation of E.T.U. residues on both tomato foliage, and fresh and processed fruit sprayed with various Maneb and Mancozeb formulations.

OJBECTIVE:

To study the residue levels of various formulations of both Maneb and Mancozeb in field grown tomatoes under commercial conditions, thereby, determining whether the 3 days to harvest restriction presently placed on the Maneb formulation is actually warranted.

PROGRESS REPORT:

Four 3 acre plots of Heinz 1630 tomato plants were planted on May 30th, in the Stoney Point area. Each plot received one of the following fungicides, M-22, Manzate, M-45, and Manzate 200. A total of six sprays were applied during the growing season, with Fixed Copper being added to the first 3 sprays. The first spray was applied July 1st, and a regular spray schedule of 10 to 12 days was followed. A John Bean airblast sprayer was used applying the commercially recommended rate as found in Publication 363, of three (3) pounds per acre of each material on the appropriate plot.

Tomato leaf tissue samples were randomly taken from each plot during the 4th and 6th spray schedule on the following days after spraying - 0, 1, 2, 3, 4, 5, 6, and 8. Also, during the 6th spray, fresh, ripe fruit samples were collected from each plot on the following days after spraying : 0, 1, 2, and 3. A portion of the fruit was processed into tomato juice, while another portion was processed as whole pack tomatoes. The remainder of the fresh fruit taken, along with the leaf tissue samples, were placed in plastic bags, sealed, and frozen immediately after sampling at $0^{o}F$. The fresh weights were also taken at time of sampling.

Upon completion of sampling, the samples were delivered to the O.M.A.F. Pesticide Testing Laboratory at the University of Guelph for analysis. The residue analysis is presently underway on the following samples taken from each treatment.

(a) Tomato leaf tissue.
(b) Fresh fruit
(c) Processed tomato juice
(d) Processed whole pack tomato.

It is not anticipated that the analysis will be completed before January 15th, 1975. As a result, the complete results will be forwarded to O.P.A.C. as soon as they become available.

11. Mayfield, C.I. Effect of the dipyridyl herbicides paraquat and diquat on non-target organisms.

An improved colorimetric analytical assay for paraquat was developed and tested. No evidence of significant paraquat degradation in non-amended soil was obtained during 90-day incubations. Both ammonium chloride and calcium nitrate added to soil containing paraquat released some of this bound paraquat, thus modifying the mobility of paraquat in soil. Rhizobium spp. were inhibited by low levels of paraquat, especially in C-limited chemostat culture and the survival of Rhizobium leguminosarum in silica and silica/kaolin mixtures was decreased when paraquat was present. Release of Rhizobium cells from paraquat-killed pea plant nodules, and consequent reinfection of other pea plants, was significantly less than from senescent or severed plant roots.

12. McEwen, F.L., Gwen Ritcey Rick McGraw, C.R. Harris, H. Svec and J. Tolman. Control of the Onion Maggot, *Hylemya antiqua* (meigen), by use of the sterile male technique.

During 1974 approximately 6,000,000 onion maggot adults reared in the laboratory were sterilized with Cobalt 60 and released at the Keswick Marsh. The experiment was conducted in cooperation with the 7 growers in the area and comprised approximately 264 acres of onions. Releases were planned to coincide with the emergence of the first generation adults in the field and again to coincide with the emergence of the second generation. Approximately 3,000,000 flies were released for each generation. This release was calculated to produce approximately 5 sterile insects for each 1 natural insect in the field. A prolonged dry period shortly after seeding in the Keswick Marsh caused flies to lay their eggs below the soil surface and it was difficult to evaluate the effect of the release program on the egg hatch for the first generation. For the second generation, egg-laying stations were set out in the field and approximately 22% hatch was observed in eggs deposited there. Growers involved in this study used the regular furrow application of granular insecticides at planting time, but did not apply foliage applications until the third generation. In general, good control of the onion maggot was obtained. Despite this, however, pupal counts in late Fall 1974 indicated that in the Keswick March the population of pupae was approximately double that of 1973. Similar counts in the Holland March area indicated that the overwintering population in 1974 was approximately three times that of 1973.

Additional tests were run on the life history of the onion maggot and on the distribution patterns of this insect in nature. Life tables indicated that the insect is very successful with more than 50% of the eggs deposited surviving to produce adults. Although three generations of the fly can be recognized, a significant number of adults are in the field throughout the growing season from May 30th to the end of September.

Dispersal studies indicated that although the fly travels a significant distance when food sources are not available, the distribution of the fly in an onion field does not suggest long distance movement, but does suggest an oriented movement predominantly into the wind. Plans for 1975 call for an intense program in the Keswick March to reduce fly populations to a minimum. This will be accomplished through intensive spray programs on the first generation flies and the release of 10-12,000,000 adults against the second and third generations.

13. Ontario Fruit and Vegetable Grower's Association (Report authored by: Kinoshita, G.B., Harris, C.R., Svec, H.J., and McEwen, F.L.). Biology and control of flea beetles attacking minor vegetable crops grown in Ontario.

Recent reports of increased flea beetle damage to minor crops in Ontario have prompted research on these insect pests. Flea beetles cause considerable damage by defoliation and root injury. The adult beetles feed on germinating seeds and seedling transplants as well as on maturing leaves Flea beetle larvae can reduce the marketability of root crops such as radish and rutabaga. Reasons for increasing flea beetle infestations are not known. To investigate the problem,the crucifer flea beetle, *Phyllotreta cruciferae* Goeze, was chosen as a model around which other flea beetle studies could be based in future.

In 1974 studies were initiated on the biology and control of the crucifer flea beetle with support from the Ontario Pesticides Advisory Committee. Beetles were found to overwinter directly in an unplowed field under leaf litter and in the soil. Adults emerged very early in the spring and fed on cruciferous weeds and volunteer seedlings. As soon as the first cole crops were transplanted beetles moved to the cultivated area and remained there until the fall. There were 2 peak periods of adult infestation with the overwintering population peaking on or before June 5 and the next generation at the end of August. In a food preference survey most flea beetle adults were found on rape, rutabaga, and Chinese cabbage.

A laboratory rearing program was initiated to mass produce flea beetles for life history studies and toxicology tests. The crucifer flea beetle has never been reared continuously in the laboratory and a considerable amount of time was devoted to this study. Adults are confined in a plexiglass tubing cage and allowed to oviposit in moistened muck. At present over 2000 eggs are collected weekly. Larvae feed on growing rape, rutabaga and radish seedlings and pupate in the soil beneath the plants. Adults of the F_2 generation are now being collected.

Field-collected adults were used for contact toxicity tests in the laboratory using the insecticides presently recommended for flea beetle control, some organochlorine insecticides and some experimental insecticides. In relative terms all of the insecticides tested were highly toxic to flea beetle adults. The data indicated that the flea beetle population found at the Research Institute Field Station is susceptible to organochlorine, organophosphorus and carbamate insecticides. Microplot studies were set up to assess the efficacy of present insecticide recommendations for flea beetle control. All of the insecticides tested were effective to some degree in protecting foliage.

It has been suggested that the incidence of flea beetle damage to crucifers may be associated with declining residues of DDT and dieldrin in soil. To test this hypothesis microplots containing Plainfield sand were treated in duplicate with dieldrin or DDT using 3 different rates of application. The microplots were subsequently seeded with radish. Soil analysis showed a gradual decline in insecticide residues throughout the season. Beetle damage is being related to residue levels in the soil in a two-year study.

14. Ontario Fruit and Vegetable Grower's Association. Feasibility of implementing a pest monitoring system for apple growing areas of Ontario.

Studies on development of a pest management program for pests of tree fruits have been underway since 1969 involving Agriculture Canada, the Ontario Ministry of Agriculture and Food and the Ontario Ministry of the Environment. Orchard sprayers have been evaluated and recommendations on use and maintenance of spray equipment have been developed. Pest monitoring procedures for economically important insects and diseases have been developed involving the use of pheromones in some instances. A pilot pest management program has been initiated in the Georgian Bay orchards involving eight monitoring stations. Results to date indicate that commercially acceptable crops can be produced in intensely monitored apple orchards with only few precisely-timed insecticide treatments.

15. Ontario Fruit and Vegetable Grower's Association. (Report authored by Fisher, R.W., and Hikichi A.). Spray application techniques to reduce pesticide load on row crops.

A survey was made of 17 sprayers in 4 locations that varied from homemade boom to commercial boom to airblast. No two sprayers had the same emission equipment. Eleven different nozzle types and seven different boom designs were used. The three airblast sprayers were from different manufacturers. Fluorescent dye tracer was used to assess coverage on the under surface of lateral leaves of cabbages. Growers used eight different chemicals in varying combinations and numbers of applications. Damage by loopers was recorded. Coverage ratings varied from 0.5 to 2.8 based on a scale of 1 to 10, where 10 is total coverage. Acceptable control was obtained with three of these sprayers for fresh market and ten for processing. As many as nine applications were used but a few achieved good control with two or three applications. While proper timing and choice of material appeared essential to obtain this control, the spray coverage ratings above 2.2 suggest that it is involved also.

Field tests on broccoli, chinese cabbage, cabbage, cauliflower, brussel sprouts and rutabaga with hydraulic boom-type sprayers showed that spray coverage on the underleaf surface can be improved in a number of ways. On cabbage for example, a rating of 5.4 or an increase of 2.6 over the best rating in the survey was obtained.

Addition of a surfactant improved the coverage rating on these crops by an average of 1.1. The increase in coverage was most evident on cabbage, cauliflower, and broccoli, probably due to the waxy nature of the leaves.

Though the increase in pressure from 100 to 300 p.s.i. resulted in a coverage from 3.5 to 5.1 on broccoli, a comparison between 60 and 100 p.s.i. showed only a slight increase with different nozzles and nozzle arrangements. Coverage decreased on chinese cabbage with increased pressure.

Increase in travel speed from 2 to 3 m.p.h. at 60 p.s.i. resulted in decreased spray coverage on all crops except cauliflower where no difference was found with overhead fan sprays. For fan jets (8002), the coverage improved with increased speed on cauliflower and brussel sprouts.

A boom with flat fan 8002 nozzles with no droparms must be operated at 200 p.s.i. or higher. Nozzle systems 8002, hollow cone $D_3$25, and full cone $D_2$33 on droparms are satisfactory at 100 p.s.i. when travelling at 2 m.p.h.

Nozzle system $D_2$33 gives best overall coverage for cabbage, cauliflower, brussel sprouts and rutabaga (at 100 p.s.i. and 2 m.p.h.).

For spraying monocultures $D_2$33 is best for cabbage and cauliflower, while all three systems on droparms are about equal for sprouts and rutabagas.

16. Smith, S.M., Downer, R.G.H., Wright, R. and Chance, Mary. Mosquito control in Ontario.

The objective of this "research" project is to provide the Ontario Pesticides Advisory Committee (OPAC) with a review of the biology of the mosquitoes of Ontario and of the background information needed to define, recognize, and implement, control operations. The hope is to place mosquito abatement in Ontario on a more solid footing and to point out the most critical areas in need of research.

The accomplishment of this objective is a very large undertaking and four university personnel are involved, each bringing their own area of expertise to the review: Dr. R. Wright (Guelph), Dr. R.G.H. Downer (Waterloo), Dr. S.M. Smith (Waterloo) and Dr. Mary Chance (Waterloo).

Our approach to the mosquito review has been undertaken from three points of view or dimensions:

1) A comprehensive review of the mosquito literature, particularly as it pertains to the Ontario situation. This review is largely the responsibility of Dr. Chance who has accumulated a very large store of pertinent literature, with considerable aid from the computerized "MODABUND" mosquito-literature retrieval system which was purchased from the University of Notre Dame specifically for this project.

2) On-site visits to operational abatement districts in various parts of North America. Two visits were of primary importance: a visit to several abatement districts and research laboratories in California. This provided an overview of the mechanics of running abatement programmes in a state which has had very considerable experience along that line as well as an up-to-date appraisal of novel methods of mosquito suppression, particularly insect hormones. A second visit was to Edmonton where a large-scale abatement programme was inspected in detail. This visit provided valuable information on the "logistics" of mosquito control operation over large areas.

3) Surveys of various components of the Ontario "Public" such as residents of communities (three communities have been surveyed), visitors to Provincial Parks (several Parks in several regions of the Province have been surveyed), farmers, owner/operators of tourist resorts and municipal governments. The last two categories involve mail surveys to be run in June 1975.

Work on the project began effectively on 15 July 1974 with the arrival of Dr. Chance who bears the heavy responsibility of summarizing an exceedingly large literature. Sections on novel chemical agents and biological control agents have been completed.

17. Stephenson, G.R., Phatak,S.C. Phytotoxic Interactions Involving Metribuzin and other Pesticides.

In growth room and greenhouse experiments metribuzin interacted with malathion and carbaryl insecticides to give synergistic increases in phytotoxicity to tomatoes. For these two insecticides, synergistic phytotoxic interactions were observed in nine of twelve different experiments with a minimum of five replicates per experiment. Demeton (Systox) at the recommended rate, plus metribuzin at 0.5 kg/ha were synergistically toxic in three of six experiments. Synergistic phytotoxicity was observed in at least one experiment for metribuzin in combination with the fungicide Bravo, the insecticide diazinon, or the herbicides diphenamid and sutan. Only additive injury was observed for metribuzin in combination with mevinphos, carbofuran, endosulfan, Polyram, mancozeb, maneb, Difolatan, chloramben or trifluralin.

In a different series of experiments, the five different pesticides which had shown some synergism with metribuzin were applied, either 3 days before, or 3 days after the herbicide to see if synergism could be avoided by not spraying both on the same day. Malathion applied 3 days before metribuzin was even more synergistically toxic than when applied on the same day. However, with carbaryl, demeton, Bravo, or diazinon, synergistic toxicity was best avoided if the insecticide or fungicide was applied at least 3 days before metribuzin.

In a field study with tomatoes involving demeton, carbaryl, malathion, Bravo, or diazinon, plus metribuzin applied on the same day, the most obvious synergistic toxicity was observed for carbaryl plus metribuzin.

All of the pesticides examined on tomatoes were also examined for synergistic interactions with metribuzin in potatoes. In the two greenhouse experiments conducted, 10 of 12 different pesticides interacted synergistically with metribuzin in both experiments.

18. Wright, R.E. and Rodrigues,C.S. Ultra low volume ground aerosols of insecticides for control of mosquitoes in southern Ontario.

Two ULV (Ultra-Low-Volume) machines (Turbair Tot and Leco 100) and four formulations of insecticide applied as ULV ground aerosols by these machines were evaluated for adult mosquito control in rural recreational areas. Effectiveness of the machines and the insecticides was evaluated by comparisons of adult mosquito collections made in CO_2 traps and CDC traps before and after spraying and by the degree of mortality in caged mosquitoes exposed to the spray drift. Satisfactory mosquito reduction was not achieved in any of the six applications. Neither of the machines gave satisfactory performance in the heavily vegetated areas treated, especially in view of the large mosquito populations which quickly reinfested the areas. Proper evaluation as to the efficacy of the insecticides used was not possible because of the inadequacy of the ULV machines tested. Both ULV machines are possibly suitable for mosquito control in local open areas such as gardens, parking lots, drive-in restaurants and theatres, and small city parks, but not suitable for mosquito control in heavily vegetated areas or for large scale mosquito abatement programs.

APPENDIX VI. Publications, theses, and papers submitted to scientific conferences relating to the Ontario Pesticides Advisory Committee Research Programs, 1974-75.

Allen, B.M. and Stephenson, G.R.[1] 1974. An evaluation of various materials for reducing spray drift in herbicide applications. Master's thesis presented to the Faculty of Graduate Studies, University of Guelph.

Brown, J.R., Chow, L.Y. 1974. The effect of Dursban on micro-flora in non-saline waters. Proceedings of 2nd conference on Pure and Applied Chemistry, Helsinki, Finland.

Brown, J.R., Chow, L.Y. and Ong, C.B. 1975. Effect of Dursban upon fresh water phyto-plankton. Bulletin Environmental Contamination and Toxicology, In Press (1975).

Butcher, J. 1974. The impact of Dursban and Abate on microbial numbers and some chemical properties of standing ponds. Proceedings of 10th Canadian Symposium on Water Pollution, University of Toronto (1975).

Harris, C.R., Svec, H.J., Sans, W.W., Hikichi, A., Phatak, S.C., Frank, R., and Braun, H.E. 1974. Efficacy, phytotoxicity, and persistence of insecticides used as pre-and postplanting treatments for control of cutworms attacking vegetables in Ontario. Proc. Entomol. Soc. Ontario. In Press (1975).

Langenberg, W.J., Gillespie, T.J.[1] and Sutton, J.C. 1975. Carrot leaf blight (*Alternaria dauci*) development in relation to environmental factors and fungicide applications. Master's thesis presented to the Faculty of Graduate Studies, Unviersity of Guelph.

Vanderpost, J.M., Corke, C.T.[1] . 1975. The effects of heavy metals on the *Rhizobium metilotic Medicago sativa* nitrogen fixing symbiosis (alfalfa). Master's thesis presented to the Faculty of Graduate Studies, University of Guelph.

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1 Principal Investigator and Supervisor of Graduate Student.

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